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XI.—*Memoir on the Origin, Progress, and Present State of the Surveys in India.* By Captain Thos. Best Jervis, E. I. C. Engineers, F.G.S. & A.S.

A SUMMARY and popular account of the origin, progress, and actual state of the surveys carrying on under the auspices of the Honourable East India Company, has doubtless been considered a desideratum by many who are interested in geographical discovery, more especially as the results have recently been brought before the public, and have naturally suggested some inquiries as to the methods pursued, and the degree of confidence to be placed in what has been thus submitted to its criticism. It would indeed be a dereliction on the part of any who should enter upon the task of explaining these matters, were he to omit to notice at the outset how singularly disinterested and munificent a part this great and influential public body has taken in undertakings which, whatever may be urged of other schemes, originated in no sordid or selfish policy, and may undeniably be said to have more of a national character than any other to which their attention has been called: nay, further, which apart from the immediate exigencies of the state, have been pre-eminently calculated to speak to the steady, straightforward, enlightened principles that mark both those that direct, and those that administer the executive government of our Eastern empire.

The earliest records of the India House bear abundant testimony to the fact of the constant and lively interest taken by the Directors in the improvement of the charts and navigation of the Indian seas. Repeated instructions were sent out year after year to the local governments, to cause individual talent to be put in requisition by every species of encouragement:—log-books, astronomical and written observations to be procured and sent home, and where the originals could not be obtained, tracings were directed to be accurately made, and forwarded for compilation and publication. The patronage so wisely extended by our most gracious and excellent sovereign, George the Third, to the improvement of geographical knowledge, was thus in spirit and in letter transferred to his people in every quarter of the globe, and the steady support which other navigators and travellers experienced at the hands of royalty, were equally evinced by those who watched over the destinies of India.

Although some valuable scattered notices both of the geography and the trigonometrical operations have appeared from time to time in the Transactions of the Royal Society and the Asiatic Society of Calcutta, as well as in Major Rennell's Memoirs, and voyages and travels of a still earlier date, very little, notwithstanding, of what has been recently accomplished has, as yet, been

described in any publication generally accessible to the community, in a simple and connected form, intelligible to readers of all classes. In endeavouring to supply this deficiency, it were much to be wished that such an epitome had been ready prepared to hand by those who have successively superintended these operations, and were, therefore, most competent to do justice both to the subject itself, and to the many meritorious individuals who have been engaged in its execution, the memorials of whose unobtrusive industry and talent would, but for such notice, be entirely forgotten and lost. In default of such account, the following particulars will be received with indulgence, and probably be found acceptable, inasmuch as they are drawn from the best sources of information by one who was for many years employed on that survey, and felt an enthusiastic interest in its progress and execution. I should have deemed it presumptuous to have engaged to prepare this paper for the Society, but for the conviction that the fulfilment of such an undertaking by any other person would perhaps have been attended with considerable difficulty, and the conclusions, so drawn, might after all have been judged far less satisfactory than as they now come from the pen of a soldier little used to description, though intimately conversant with the nature of the countries surveyed, the circumstances and capabilities of the parties employed, and the several methods which were used under all the discordant and conflicting emergencies, in despite of which so much has been accomplished.

It may be expected, however, that I should preface this account with a few remarks on the progress of geographical knowledge generally, as an appropriate introduction to that of Asia, and bring it down to the period when our acquisitions in British India began to assume an importance to the country, which demanded a more energetic exercise of authority, and established the East India Company in the administration of its government. An analysis of this sort is chiefly instructive as it illustrates the march of intelligence, and the advance of the arts, and perhaps as throwing some light on communications which have occasionally been received with interest by the Society respecting the early navigation of the ancients.

In taking a cursory review of the progress of the most interesting and important departments of knowledge, it seems difficult to account on any rational principles for those singular contemporaneous fits, those widely-diffused impulses which circumstances absolutely unconnected with each other concur to produce in the minds of individuals, directing and instigating them to occupations and researches in extension of the most valuable objects and pursuits which have engaged the attention of the civilized world. Neither is the question satisfied on the ordinary plea of necessity. Take what department you will, though necessity shall be clearly

shown to have been equally imperative, and the times proportionately fertile in expedients at the periods when such inquiries were instituted, there is a ripeness of season at which every project that is started, every effort in aid of individual sagacity or industry can alone be productive of fruit. Nor are the advances to such state, although unobserved, less subordinate to this remarkable principle. Like the return of suspended animation, the first symptoms of change are almost imperceptible, but at length the new accessions of vitality and strength are visibly increased, and the struggles of life go on with a marked and characteristic rapidity till the recovery is perfect. And it is thus, more probably, with that unnatural state of ignorance which has hitherto supervened for many ages, than to any progressive advance of the mind, whether intuitive or produced by external causes, that we should rightly apprehend the present strides of science. From a state of inanimation the moral and intellectual pulsation has been at first comparatively slow, and indistinctly perceived. The exhibition of every successive effort is a characteristic harbinger of higher and more rapid degrees of improvement,—an improvement which will eventually lead to every desirable approach to perfection.

Whatever may be the most rational account of this remarkable and simultaneous concurrence of events, many people are content to dismiss the difficulty, by referring it either to the particular occasions which call forth individual talent, or to the influence of certain master-spirits on the subsisting state and character of society. And doubtless it is on this showing, that War or Peace, Freedom or Servitude, commercial enterprise or despotic tyranny, are presumed by one or other of us to operate as so many spurs or checks to the further progress of the human race in the chief desiderata of Science and Art. Without going at any length into the proofs of this assertion, we might advert to the remarkable literary inquiries and establishments in the eighth and ninth centuries, instituted or fostered at one and the same period, in connexion with the religious persuasions of the Christians, the Mohammedans, and the Booddhists. The peculiar encouragement thus held out to the cultivation of the Latin by Charlemagne and his immediate successors in France and Germany; of the Arabic by the Khalifs Almunsor, Haroun Alraschid, and Mamoon; and by the respective sovereigns of India, Thibet, and China, of the Sanskrit, Pali, and Thibetian languages;—these were eminent though unconscious precursors of those subsequent discoveries, to which we now recur with especial admiration.

Geographical science furnishes also another and appropriate illustration of this fact. The simultaneous exertions of many individuals wholly unknown to each other, to institute inquiries preparatory to that enlarged and more exact acquaintance with the

relative situation of countries and objects on the surface of the globe, its precise form, dimensions, distribution, and local peculiarities; these all have followed successively at intervals, as investigations supposed to have originated in fortuitous circumstances which some one or other of the foregoing causes had contributed to elicit or suppress. This view of the matter, however discursive it may be thought by such as are indisposed to general reflections, is of consideration chiefly, and indeed solely, as it shows us the position we actually occupy, while it presents us with a cheering and magnificent prospect of what is yet to be effected and anticipated in this most essential article of information.

The most striking feature of these investigations is sufficiently exemplified in the progress of geographical discovery from the fifteenth century, when the long dormant energies of the descendants of the Phœnicians, or the jealousy and rivalry of other nations prevailed with the Spaniards and the Portuguese to wrest the commerce of the East from the hands of the Venetians, or to strike out new and unexplored paths for industry, enterprise, and social intercourse, in subservience to the spread of what was usually held out to be the paramount design, the communication of religious truth. The great object of the Portuguese, in point of fact, may probably be referred to their anxiety to dispossess the Venetians of their important commercial advantages in Egypt. The memorable treaty of that people with the Mamelukes, and their arrangements to defend the desert against the Portuguese, sufficiently demonstrate the real spirit of the restrictions to the first navigation to India. The severe system of taxation imposed by Sultan Selim, who conquered Egypt in 1512, and the avarice of his successors, contributed also to engage the Portuguese to follow up the discovery of India by that of still more remote lands—for then only were the great commercial importance of their discoveries rightly understood.

Whatever may have been the amount of our acquaintance with Asiatic countries, and India in particular, previous to that time, it would serve us little to examine more particularly, excepting only as it affected the question of the maturity of science in past ages. That the intercourse of the ancients was more extensive, even with the remotest parts of Asia, than has been usually admitted by European writers, will unquestionably be agreed to on examination, and thus a multiplicity of customs, laws, and institutions be legitimately referred to a common origin, which on any other supposition are altogether inexplicable.

The Spaniards unexpectedly arriving at their destination by a much shorter route than the Portuguese, left the latter uninterruptedly to pursue the great design of reaching India by sailing easterly; and of the courage and boldness of the two nations, we

may be disposed, on mature reflection, to doubt whether the palm was not more justly due to the Portuguese. It was indeed a bold step, after having advanced so far to the south, to turn to the east, and realize in some sort the first move to the circumnavigation of the globe, since it was in fact almost on the very heels of the first adventures of the Portuguese that this great problem was solved by Sir Francis Drake* and Oliver Vander Woort. The voyages undertaken by the Spaniards and Dutch to the Spice Islands were likewise as stepping-stones to a greater achievement, the honour of which was reserved for our own country, just one hundred years after Bernal Diaz rounded the Cape.

And here it may be pardonable, in reference to the early commerce of the ancients, to advert, though briefly, to the singular advantages, in a geographical point of view, which the Jews possessed over every other nation of the earth, inasmuch as that remarkable people, being the chosen depositaries of institutions and laws pre-eminently superior in their moral and social tendency, they were thus in a manner encouraged and counselled to the fulfilment of higher objects in the designs of Providence, by the most extensive interchange of the commodities of their own for those of other distant lands. Palestine, as it were, the key to the commerce of the whole earth, was accessible to the shores of India, Arabia, and the eastern coast of Africa, by a branch of the Red Sea. By the Mediterranean its communications with the northern and western coasts of Africa, the eastern shores of Europe, and by no very hazardous route with the shores of America, were equally easy, while the Black Sea, the Caspian, and the Persian Gulf, presented facilities in other quarters which no other country could have boasted of. That the ancients had a knowledge of those countries, and that they had actually circumnavigated Africa, is as probable an inference, from the testimony of Herodotus, as that the intercourse with the East was familiar to the Jews so early as in the reign of Solomon, when they trafficked for ivory, apes and peacocks, since the latter are peculiar to the countries east of the Indus. The testimony of Herodotus to the circumnavigation of Africa by the Phœnicians is remarkable, and to many may appear as conclusive as curious. The authenticity of the passage indeed has, like many others of a similar description, been disputed by critics on account of the remark that "when autumn arrived they drew to shore on that part of Libya opposite to which they might be, sowed the grain, and awaited the harvest, which, when they had reaped, they again set sail ; a conclusion, however, which, as well as that of the sun's rising on the right hand as they rounded the extreme promontory, and the resistance opposed to

* The motto given to Sir Francis Drake by Queen Elizabeth quaintly expressed his merits—"Tu primus circumdedisti me," surrounding a terrestrial globe.

their further progress by the contrary currents and accumulation of sea-weed in 14° S., mentioned at the termination of the narrative, all bespeak alike the fidelity of the historian and the veracity of his informants.*

These are considerations, however, which many may reckon more fanciful, or at best, more speculative than conclusive and useful. Let it be remembered, however, that one step made towards the solution of any difficulty is calculated to pave the way to the solution of others :—and while we dwell on the beauties of classic literature, we are frequently tempted to discredit the accuracy of the author on the ground of one mis-statement, or disparage his writings on the score of puerility or fiction. Thus also, when tracing similarity of moral institutions and civil usages in remote parts of the earth, where intercourse had not been suspected,

* “I wonder at those who divide and lay down the boundaries of Libya, Asia, and Europe, as if the difference between them were not very great; for, while in length, Europe extends along both, no comparison can be formed by which to estimate their relative width. Libya declares itself to be circumnavigable, except where it is bounded by Asia. The first person known to have proved this was Necho, King of Egypt. When he ceased to carry on the canal leading from the Nile to the Arabian Gulf, he sent out some Phœnicians, instructing them to sail round by the Pillars of Hercules (Straits of Gibraltar) to the Northern Sea (the Mediterranean), and so return to Egypt. These Phœnicians, therefore, parting from the Erythræan Sea, navigated the Southern Sea. When autumn arrived they drew to shore on that part of Libya opposite to which they might be; there they sowed the ground, and awaited the harvest, which, when they had reaped, they again set sail. Thus they continued their progress during two years; in the third, doubling the Pillars of Hercules, they arrived in Egypt. These persons affirmed, what to me seems incredible, though it may not to another, that, as they sailed round Libya, they had the sun (rising) on the right hand. In this way was Libya first made known.

“Long after the Phœnician voyage, as the Carthaginians relate, Satapses, son of Teaspes, of the Achæmenidian family, was sent to circumnavigate Libya, though he failed to accomplish his task; for, appalled by the length and desolation of the voyage, he turned back without having achieved the toil imposed upon him by his mother. This Satapses had violently insulted a daughter of Zopyrus, son of Megabysus; for which offence he was about to be impaled by the order of King Xerxes, when his mother, who was the sister of Darius, interceded for him, saying that she would inflict upon her son a still greater punishment, for she would lay upon him the necessity of circumnavigating Libya, until he should arrive in the Arabian Gulf. Xerxes consented to this proposal, and Satapses going to Egypt, there hired a ship and mariners, and thence sailed through the Pillars of Hercules. Having passed these, and doubled the extreme point of Libya, which bears the name of Solœis, he sailed southward; but after traversing, during many months, a vast extent of sea, and knowing that still more must be passed, he turned his course, and sailed back to Egypt. Thence he proceeded to Persia, and presented himself before Xerxes. He said, that on the remotest part of the coast along which he sailed he saw men of diminutive stature, clad in leaves of the palm tree, who, whenever the sailors drew to shore, abandoned their towns, and fled to the hills. His people entering, did the natives no other injury than taking their cattle. The reason why he could not sail entirely round Libya was, he said, that in attempting further progress his ship stuck fast; but Xerxes not giving credit to the excuse he made for not fulfilling the appointed task, condemned him to undergo his first sentence, and he was impaled. The chief officer of Satapses, instantly as he heard of his death, fled to Saos with great wealth. This treasure was seized by a certain Samian, whose name I well know, and purposely conceal.”—*Herodotus*, Book iv., Section 3.

we are in a like degree prone to conclude against a degree of civilization and intercourse, which may be founded in reason as well as in fact, from not having sufficiently examined or considered the evidences to the contrary.

The commercial expeditions to India by the Romans, the Egyptians, and at a later period by the Arabs, were of too exclusive a nature to throw much light on geography; vestiges of the former on the coast of India are still to be found throughout Malabar, where large collections of Roman coins have escaped the furnace of the goldsmith.* The Egyptian fleets were encountered by the Portuguese on their first arrival in India, and the Arabs had for many centuries colonized not only on the whole line of coast from the Persian Gulf to Cape Comorin, but had established themselves on Ceylon, and all the principal islands of the Indian archipelago. In such state of things Europeans found the navigation when they first became acquainted with it; but for the successive improvements it has undergone from this period, we are much indebted to the diligence of persons unconnected with official duties.†

The circumnavigation of the globe was, however, too much to be taken on trust, and the relative situation of countries needed further confirmation. These were pursued with unabated curiosity, till in seeking to assign to objects their proper place on its surface, the precise form of the earth and its dimensions, new and still more intricate problems were found to be indispensably necessary. It is in this stage of the proceedings that we purpose to notice the most prominent particulars connected with the geography of Asia, more especially those departments of it which relate to India, and the valuable maritime surveys instituted and carried on by the public spirit and munificence of the Honourable East India Company.

The contemporaneous experiments of Picard in France, of Snellius in Holland, and Norwood in our own country, for the measurement of a degree on the meridian, had given rise to many curious speculations, which, in conjunction with the mathematical deductions of Huygens and Newton, revived in the early part of the eighteenth century the contested problem of the determination of the earth's ellipticity. In the researches incident to such inquiries, much new geographical matter had been added to that acquired from other sources, and every resulting formula so obtained was systematically applied by Cassini and Danville to the improvement of the charts and maps of other countries. They

* A very large and most valuable collection of these coins is now in the possession of a native at Palghautcherry; and Mr. Sparks, of the Madras civil service, told me he had been particularly successful in procuring many rare specimens in that province.

† Horsburgh, the self-taught cabin-boy, and one of the first hydrographers in the world, is an instance in point.

were indeed remarkably qualified to originate geographical projects, and reduce the stores of information which were daily flowing in from all quarters, and for a considerable period the maps of the latter as respects India and the neighbouring countries were the best we had. But a vast field had at length been gradually opening out for like investigations in India, as in Europe, by the extension of the theatre of war to the most distant and hitherto unexplored provinces, and the gradual subjugation of the princes lately confederated with the French nation. Major Rennell of the engineer corps, whose celebrity as a geographer is familiar to all of us, was the first person who reduced the miscellaneous materials collected by British officers on the same principles, and in pointedly stating his obligations to Mons. D'Apres' *Neptune Orientale*; and to M. Danville's maps of Asia and India, published in 1751 and 1752, he eulogises with astonishment the skill and tact with which that excellent geographer availed himself of the scattered notices derived from vague itineraries and books of travels.

This observation of Major Rennell, respecting Danville, may lead us to estimate the peculiar talent which enabled him also, under existing circumstances, to produce so much valuable information respecting countries that were inaccessible to European observation; it was the talent of comparing and collecting, the habit of selection, and a judicious application of such selection to one uniform system—requiring no ordinary share of patient investigation and deference to truth, to the exclusion of whatever might be either speculative or unknown. A memorandum or simple route enabled him under such restraints to fix the position of many interesting places with a very tolerable degree of precision. To everything there must be a beginning, and with reference to those who are disposed to undervalue labours of this sort, it may be well to offer in extenuation that the master hand is as frequently displayed in the first rude outline or design as in the finishing touches of a portrait; and a hasty sketch is, in its way, calculated to express frequently as much as can be conveyed by a more perfect delineation. With regard to Major Rennell's opinion, that the public records at Goa contained much that might have served to illustrate eastern geography generally, he was doubtless misinformed, as I had the most unlimited access to everything of that sort for several years, and was assured that if anything had been deposited in the archives prior to 1700, it had been abstracted or destroyed at the instance of the Marquis of Pombal.

Having once laid down a general plan, everything additional fell in its proper place, and served at least to recommend more perfect and accurate surveys to succeeding investigators. Such as his information was respecting Berar and Bengal, it is still the

most complete we possess, though the rewards and credits were in a measure bestowed on a far less gifted and successful observer, Colonel Charles Reynolds. There is one way, however, of satisfying those who are over-scrupulous, and can find no merit in adjustments so dependent, as they may argue, upon chance, which I will venture to affirm is unanswerable, and that is, a comparison of the latitudes and longitudes of the principal points determined by Rennell, and the results of the great trigonometrical survey. The coincidences indeed were more than sufficient to justify that remark made many years ago by Johnson, in his *Tour to the Hebrides*, that many parts of India were better known than the northern parts of Scotland.

Many very intelligent officers soon followed in the train of Major Rennell; Captain Moncrieff, of the Bombay Engineers, Captain Mackenzie, of the Madras Engineers, and Colonel Charles Reynolds, who were all three very early distinguished for their capacity in this line. The former, in his progress through Canara and Malabar, produced a valuable geographical sketch of those provinces subsequently incorporated by Colonel Reynolds in his large map of India.*

It is not too much to conclude that some portion of the characteristic spirit of Rennell had been communicated to all those who were placed in connexion with him in his official capacity of surveyor-general; for about the time of the publication of his *Memoir of a Map of Hindoostan*, a variety of documents were placed on record, which were suffered to pass unnoticed, and there is still much in them which would deserve preservation. On the 14th January, 1780, Mr. Charles Chapman was deputed to the government at Cochin China, to inquire into the advantages of a commerce with that country, and to endeavour to establish a freedom of trade to all the Company's settlements, under sanction of the ruling power of the place. A narrative of his proceedings and observations on Cochin China and Tonquin, in pursuance of this mission, was forwarded to the Court. Another document, with a set of drawings of lands as they appear in the eastern passage to China, according to the bearings laid down, was sent in by Mr. George Grey Townshend, on the 24th January, 1791; and a further description, with charts of Cochin China, by Mr. George Taswell, on the 9th August, 1799. Lieutenant-Colonel Kyd, of the Bengal Engineers, Mr. Ritchie, Colonel Colebrooke, and Captain Blair,

* Captain Reynolds' Survey of Bednore, on a larger scale than any which had then been attempted (four miles to an inch) first brought him into public notice, and deservedly so, both from the minuteness and accuracy with which it was executed, and its extent and completeness, considering how very few there were at that time who paid any attention to science.

furnished at intervals various astronomical particulars, and written information respecting the Ganges and the Hoogly rivers, as did Lieutenant Wood, Mr. Reuben Burrows, and Mr. Michael Topping, on the coasts of Arracan, the Delta of the Ganges, and the latter of the entire eastern coast, from the embouchure of that river to Cape Comorin. The volume of astronomical observations by Mr. Reuben Burrows, 31st January, 1791, may probably contain many well-determined points which have not yet been ascertained either by Captains Ross, Crawford, or Grant. They are accompanied at least by sketches of the coast, done with much care, and referred to a series of bearings, latitudes, and longitudes, which is to be inferred from the fact, that the entire book is throughout in the hand-writing of that skilful mathematician.

Mr. Michael Topping's observations on the currents in the bay of Bengal, of the 1st March, 1788, on the 16th January, and 26th June, 1792, may probably be found of essential importance in future investigations respecting the retreat or advance of the sea on the east coast of India, and the exact registration of the tides. His survey of the mouths of the Godavery river and Coringa road, 18th September, 1790, and 21st January, 1791, and his proceedings and report in the Masulipatam Circar, drawn up with a view to ascertain the practicability of applying the waters of the rivers Krishna and Godavery to the fertilization of the land, with charts, observations, and levels, communicated 20th February, 1794, and 2nd October, 1795, may yet induce the Madras government and authorities at home to reconsider that valuable project.

I have drawn up this summary account of a few of the most remarkable attempts to add to our stores of geographical and hydrographical information before the conquest of Mysore, during which interval the office of surveyor-general had been held successively by Colonels Call, Charles Reynolds, and Colebrook. I should not omit, however, to notice the valuable maritime surveys of Captains Huddart and M'Cluer, and Lieutenants Ringrose, Wedgeborough, and Skinner, on the western coast of India, from 1790 to 1793, which still continue to be good authority to navigators of that coast, and were actually incorporated by Colonel Reynolds in his map. At the time they were delivered to the government an outcry was raised against their accuracy, which subsequent inquiry has shown to be without a shadow of justice; and I may mention it as a corroborative proof of the attention and skill which must have been bestowed on the subject by Captain M'Cluer, that in carrying on a trigonometrical and topographical survey of the coast upwards, with all the helps and improved methods for which our recent acquisition of the country afforded also greater facilities, I found the actual outlines of the coast and exact distances differ very immaterially from those in

M'Cluer's charts, and I had the more favourable opportunity of verifying the fact, as the superintendent of marine furnished me with Captain M'Cluer's original drafts, on a large scale, for this express purpose.

Such was the state of our acquaintance with India down to the breaking out of the second war in Mysore in 1799, established for the most part on the valuable deductions of Major Rennell and Danville, whose labours were eventually incorporated with a mass of native information of indifferent character in the large map of Colonel Charles Reynolds. And here it may be well to pause for a while, and take a general review of the state of geography in India as compared with that of our own country, where many of us would willingly believe some much more marked advance had been made to an accurate acquaintance with the position and superficial extent of the British territories, than in less civilized lands; and that a maritime nation at least, such as England, had been long in possession of the most accurate charts of its own shores, which should enable its shipping, in the event of anticipated peril or stress of weather, to avail themselves of every advantage presented by peculiar natural localities.

In countries where the inhabitants are comparatively backward in point of civilization, where there are but few large towns, where commerce is not the primary pursuit, and there are hardly any great roads, the delineation of the great features which they present has usually been deferred till they have become the theatre of war, and even then are supposed for all ordinary purposes sufficiently complete by the collation of routes, corrected here and there by observations for latitude and longitude. It is argued that the difficulties to be surmounted, and the advantages to be expected, could never be commensurate with each other, nor would the expense of money and life thus bestowed be in any adequate degree compensated by the information acquired. Where so much is necessarily left to imagination, it is inconceivable how little dependence is to be placed on the generality of such compilations, how much interpolation and repetition also of rivers and towns, and other principal objects, are incident to the mere inconsistencies of orthography. My particular attention was drawn to the latter circumstance, on going over the tract of country on the western coast of India, and comparing the actual survey with that compiled by Colonel Charles Reynolds in 1798.

Moreover, as in route surveys much is left to the eye, to the judgment of the observer in estimating distances, as well as to his candour in drawing inferences from the various descriptions of information presented to him, it very rarely happens that any two practitioners, and they are usually self-taught amateurs, arrive at the same conclusions. The very same provinces, therefore, whic

purport to have been laid down from the most accurate observations of such persons have occasionally a degree of dissimilarity to each other, which leaves the compiler quite at a loss on what principle to reconcile their discrepancies. The repetition of such surveys serves only to increase perplexity, where some even of the principal towns and geographical features are most uncereemoniously shifted several miles, while their exact position is still matter of doubt, if happily he should not find them in two places wide apart.

Such, anterior to the commencement of the great trigonometrical survey in Great Britain, was the only method in general use, and it will not be out of place to mention that there were then errors in the positions of some important points, as the Lizard, to the amount of seven minutes of a degree, and that many of the best county maps exhibited blunders of three miles in a distance of less than twenty.

The various surveys throughout India and in Bengal, to a still later date, have, with few exceptions, been conducted in like manner, and the maps of districts under the latter presidency have, in consequence, been proportionally erroneous. To remedy this defect has long been desired, but it is a task not easy at first sight to determine how a measure fraught with so many difficulties is to be effected without an extravagant outlay of money.

The great map of India constructed by Colonel Reynolds was formed also on the foregoing principle. One extensive line of route running through several degrees of latitude from Goojerat to Hindoostan, and corrected where it terminated on either side by observations of latitude, having been measured with considerable care, constituted a primary basis, to which other routes diverging on either hand were referred, and the intermediate spaces filled in from native information, or the labours of his assistants, Colonel Monier Williams, Sir James Sutherland, and other officers. This was until very lately the foundation of the entire map of Cutch, Kattywar, Goojerat, Hindoostan, and Rajpoothana, corrected at times by route measurements under his successor Colonel Monier Williams. The expense of this imperfect geography from first to last has been incredibly great, but the reputation of Colonel Reynolds' system and of his successors in office stood so high with the Bombay government, that every suggestion for improved and more conclusive surveys was invariably negated as superfluous.

A collection of routes and other information collected by Colonel Kelly, and suggestions for the improvement of the south of India, by Lieutenant-Colonel Gent, chief engineer at Madras, on the 28th January, 1784, followed up by a large and valuable compilation of routes by Captain Mackenzie, during a period of twelve years, four of which were incessantly devoted to that duty

constituted the basis of the geography of the south of India, lying principally between the Krishna river and Cape Comorin. Captain Mackenzie's labours began towards the close of the war of 1783, in the provinces of Coimbatour and of Dindigul, afterwards in the course of his professional duties as an engineer in the provinces of Madras, Nellore, and Guntoor, throughout the whole of the war from 1790 to 1792 in Mysore, and in the countries ceded to the Nizam by the peace of 1792, from which period till 1799 he was engaged in the first attempts to methodize and embody the geography of that prince's territories and the Deckan, interrupted only for a short period by the voyage and campaign to Ceylon in 1795-6. The peculiar talents of Captain Mackenzie for geographical and statistical inquiries had been early brought to the notice of Lord Cornwallis, and his deputation to the Nizam's dominions, at the conclusion of the campaign of 1792, enabled him to reduce the materials for the map of that prince's territories to some degree of order. This map with the routes, memorandums, and notes, constituted the most useful exemplar of military survey, and contains, besides actual measurements, a multiplicity of curious and useful remarks on every subject that fell within his reach.

But a new and important era was now opening on this department of knowledge throughout the civilized world. The defectiveness of the best British maps, the revolutionary turn of affairs in France, and an accidental circumstance of the most unlooked-for nature led in each of these countries to the entire remodelling of the respective surveys.

The British government having deputed Lord Macartney on an embassy to the Emperor of China, charged their ambassador with various magnificent presents, and amongst others some which perhaps even our modern intellectual diplomatists would consider a little out of character, a beautiful zenith sector and 100-feet steel chain, constructed by Ramsden, a levelling and transit instrument, besides other apparatus of a like costly and scientific description. The Emperor having declined this conciliatory offering, the embassy stopped at Madras on its return homewards, and on coming to a reckoning with Dr. Dinwiddie, the astronomer and physician who had accompanied Lord Macartney, the luckless instruments were assigned to him in part payment of his salary. The mathematical abilities and philosophical turn of mind of Colonel Lambton, at that time a lieutenant in H. M. 33rd regiment, had not escaped the observation of its distinguished commandant, the Honourable Colonel Wellesley. Lieutenant Lambton, who was at that time officiating as brigade-major to Sir David Baird, having accidentally become acquainted with the circumstance, and confident of his own powers, made interest

that these valuable instruments should be rescued from the auctioneer, and turned to some national account. The Earl of Mornington, the governor-general, on the final reduction of Mysore in 1799, being then at Madras, concurring with his brother in the advantageous opportunity thus presented for carrying on an extensive survey of the Mysore dominions, further nominated Captain Mackenzie to the topographical details, while the statistics were assigned to Dr. Buchanan.

Events had thus fortunately concurred to the furtherance of the design proposed by Lieutenant Lambton, and humble as this tribute may appear, it is no less just than due to ascribe the first encouragement of the measurement of the largest meridional arc that has ever yet been undertaken throughout the world to his Grace the Duke of Wellington. Every one who has experienced the difficulty of maturing any useful project, can better appreciate the patience and foresight which could have led his Grace to recommend Lieutenant Lambton's novel scheme to the government of India, prepossessed, as it had hitherto always been, in favour of the sufficient accuracy of mere geographical and route surveys.

At his Grace's suggestion to Lord Mornington, Mr. Petrie and Lord Clive, then Governor of Madras, the instruments were purchased on account of Government, and in furtherance of this project, a large theodolite similarly constructed to that used by General Roy, as also an altitude and azimuth circle for secondary triangles were made in England by Cary, and by the year 1801 all the requisite apparatus was at Lieutenant Lambton's disposal.*

In the year 1800 a plan of the intended operations was submitted to the government of Fort St. George, and with their sanction published in the seventh volume of the *Asiatic Researches*. It was here proposed to join the coasts of Malabar and Coromandel by a series of triangles, which might be extended on the south to the extremity of the peninsula, and to an indefinite distance on the north, on a plan similar to that which had lately been adopted in France and England. In the month of October of that year, a base line was measured near Bangalore, and the first experiments were made with the zenith sector at Dodagoontah. In the early part of 1802 a base line was measured near Madras, and in the mean time a new chain had been received from Mr. Ramsden, which professed to have been laid off at the temperature of 50° Fahrenheit from that artist's bar.

Lieutenant Lambton's first operations after this, were to carry on a series of triangles depending on the Madras base westward, to meet the Bangalore base, and finally the west coast near Man-

* Much of the excellence of these operations has been attributed to the skill of the artists Ramsden and Cary in the apparatus employed, and it is not out of place therefore to bring such high testimony before the public in the *Society's Memoirs*.

galore. In pursuance of this intention, he established the meridians of Carangooly, Kylasgurrh, Terrakondah, Severndroog, Mullapannabetta, and Balroyndroog, the positions of each of which he determined with relation to the Madras observatory. He also essayed to measure two perpendicular arcs, viz., those connecting Severndroog with Yerrakondah on the east, and Mullapannabetta on the west side, each being nearly sixty-seven miles in length.

No country or circumstances could have been more favourable for such an attempt, whether we regard the skill, intelligence, and zeal of the operator, the excellence of his instruments, the liberality and freedom from restraint which he experienced on the part of the Government, or the fortunate situation of the eminences on which his stations were chosen. But it was his opinion that he had failed entirely in deriving any results to be depended on from his perpendicular arcs; and it is now, I believe, the general opinion among mathematicians that longitudes cannot be determined by this method, but must be deduced from other sources.

About the same period Lieutenant Lambton carried a series to the southward, which terminated at a place called Trivandapooram, near Cuddalore. Here he determined the latitude by a sufficient number of zenith distances, and he then proceeded to Pauredre, a place nearly under the same meridian, where, by another set of zenith distances, he found the amplitude of the celestial arcs between the north and south points of a small meridional series, in middle latitude $12^{\circ} 32' 21''$. This arc forming no part of the principal meridional series, which passes through Dodagoontah, was subsequently carried by him to the southward down to Punnae, near Cape Comorin, and finally to the northward as far as the parallel of 21° nearly; but as the particulars of these operations are all in the possession of the Court of Directors, it would be superfluous to enter into any description of them in this Memoir. The meridians of Severndroog and Dodagoontah are so near to each other, that the same series connects both: for geographical purposes, such as the determination of latitudes and longitudes, the former is used, the latter only being reserved for scientific details.

The measurement of a base of verification, and the observation of a set of zenith distances near Beder, in the year 1815, by Lieutenant-Colonel Lambton, brought the great meridional series up to the parallel of $18^{\circ} 4'$, and with it, of course, the series of Severndroog. In 1817 this series was continued to the northward to the Godavery river, the triangles then branched off to the eastward to meet the Yerrakondah meridian, down which a series was carried to the former points on the Krishna. In 1819

Colonel Lambton determined to bring up the series of Carangooly to the same parallel with those of Yerrakondah and Severndroog; but as the operations proceeded the features of the country seemed favourable for completing the intermediate series of Kylasguruh also, and by the end of 1820 both these series were satisfactorily conducted to the Godavery, though, it must be observed, that the unhealthiness of the tracts was such as to occasion great loss of lives, and to ruin the constitutions of almost all engaged in the laborious task. In the two following years the meridional arc was extended to Ellichpoor, and a base of verification measured in the valley of Berar by Colonel Lambton in person: the lateral series connecting Bombay with the base line at Daumergiddah, in latitude $18^{\circ} 3'$, was temporarily interrupted by the death of this distinguished officer on the 20th of January, 1823. From that period the operations have devolved on Major Everest, F.R.S., whose conjoint labours with Colonel Lambton have been brought before the public in a separate publication. Major Everest has subsequently carried on the meridional arc from Seronj, in latitude $24^{\circ} 7'$, to Kedar Kanta, in the Himalaya mountains, in latitude $31^{\circ} 2'$, verified by a base line in the Deyra Doon, situated near the foot of those mountains.

A lateral series connecting Calcutta and Benares with the great meridional arc at Seronj, by Mr. Oliver, and another series from Bombay, by Lieutenant Shortrede, has established the relative positions of the three principal stations in India.

A series of triangles by Captains Ward, Conner, Garling, Snell, and Jervis, has been carried on in the different provinces south of the 20th degree of latitude; and other lateral series, on four distinct meridians, are in progress to the eastward of the meridional arc, by Lieutenants Wilcox, Boileau, Macdonald, Waugh, and Renny.

I have purposely abstained from any observations on the continuation of the operations by Major Everest, as they will probably be given to the public by himself at no distant period, but consider it a theme of pride to our country to have had two so highly distinguished and competent mathematicians as Colonel Lambton and Major Everest, and that the latter should have lived to have brought to a completion the most extensive, and probably, I may venture to add, also the most accurate measure of the earth that has yet been accomplished. Punnae, the southern extreme, is in latitude $8^{\circ} 9' 38''$; Kedar Kanta in $31^{\circ} 2'$. The total arc, therefore, is about one-sixteenth of the entire circumference.

On this triangulation as a basis, and on the various lateral series carried on by the officers and élèves of the excellent military institution established at the suggestion of Colonel Colin Mackenzie, of the Madras Engineers, and ably superintended for

many years by Captain Troyer, the whole of the peninsula south of the Krishna has been minutely surveyed in detail. The whole of the Bombay Presidency, Khandesh and the eastern portions of Goojerat only excepted, remain unfinished. Of the Nizam's or Hyderabad territories a large portion has been accurately surveyed. The Rajah of Berars, or Nagpoor dominions, have also been triangulated and surveyed, though with less attention to accuracy. The survey of the Northern Circars by Lieutenants Sackville, Buxton, and Snell, completes the portion designated as the Peninsula. North of this, of which the Nurbudda is the boundary, a very large portion under the Bengal Presidency has been likewise surveyed, according to the methods already adverted to, that is, route surveys corrected by astronomical observations; and on the eastern frontier much geographical matter has been added by Lieutenants Wilcox, Pemberton, and Grant.

But we reserve the more complete and exact details, both of these surveys and of the still more important and valuable surveys conducted by the officers of the Indian Navy, to a future opportunity.

[*To be concluded.*]

XII.—*Notice of the Mountain Aconcagua in Chile.* By Captain Robert Fitz Roy, Royal Navy.

DURING the Beagle's survey of the Chilian coast, it was ascertained that the mountain Aconcagua was higher than the famed Chimborazo. By the mean of the results of many observations made by the Beagle's officers at different stations on the coast of Chile, near Valparaiso, the height of Aconcagua above the sea appears to be 23,200 feet. Of various observations made at different times, no one result was less than 23,000, nor more than 23,400 feet.

According to recent accounts, the highest mountains in South America are—

Sorata, whose height is said to be	25,400 feet
Illimani, said to be	24,200 "
Next to which Aconcagua claims a place, as	23,200 "
Gualtieri is said to be	22,000 "
And Chimborazo	21,000 "
above the level of the ocean.	

Amongst a variety of data for calculating the height of Aconcagua, the following are considered the best:—

Observation made at Fort San Antonio, Valparaiso, with a good theodolite, forty feet above the level of the sea at half tide. Angular elevation of the highest point of Aconcagua above the